

1 WE CLAIM:

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1. A thermally-integrated low

temperature water-gas shift reactor for converting

carbon monoxide in the presence of steam to form carbon

dioxide and water comprising, in combination,

a) a waste-heat recovery steam generator

for the beneficial recovery of exothermic reaction heat

to generate steam that is used in a process for the

conversion of hydrocarbon feedstock into hydrogen-rich

gases,

b) an outer region extending about said

waste-heat steam generator,

c) a catalyst bed located within said outer

region, and through which reformat gases flow,

d) the outer region being in heat transfer

communication with the steam generator to maintain the

catalyst bed within a predetermined temperature range

for operation of a low temperature shift reaction.

1 2. The combination of claim 1 wherein the
2 waste heat steam generator operates at temperatures in
3 one of the following ranges: 360°F to 450°F, and of
4 385°F to 400°F, that is optimum for conducting the low
5 temperature water-gas shift reaction.

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8 3. The combination of claim 1 wherein a
9 Cu/Zn catalyst is contained in an annular space defined
10 by said outer region, and having an inner wall that is
11 in thermal contact with a boiling water fluid in said
12 generator.

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15 4. The combination of claim 3 wherein the
16 boiling water fluid is located to transfer heat to the
17 catalyst bed to heat the bed during start-up.

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20 5. The combination of claim 3 wherein the
21 catalyst bed is located to transfer heat to the boiling
22 water fluid during normal operation to generate steam.

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1 6. The combination of claim 1 including
2 longitudinal heat transfer fins attached to an inside
3 wall of the annulus and projecting in said bed to
4 enhance the rate of heat transfer to and from the
5 catalyst bed.

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8 7. The combination of claim 1 including a
9 helical coil adjacent the inner and outer walls for
10 defining annular space at said annulus to conduct and
11 increase the velocity of the process gases as they flow
12 through the catalyst bed and to enhance the rate of
13 heat transfer to and from the catalyst bed.

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16 8. The combination of claim 1 wherein the
17 catalyst bed is maintained in one of the following
18 ranges: between 370°F and 550°F, and between 400°F and
19 450°F.

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22 9. The combination of claim 3 wherein the
23 annular space is typically between 1 and 2 inches wide
24 to minimize temperature differentials between the
25 outside and inside walls defined by the annular space.

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1 10. The combination of claim 3 wherein the
2 gas has hourly space velocity in the range of 500hr-1
3 to 2000hr-1.
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6 11. The combination of claim 1 wherein the
7 waste heat stem generator contains one or more heat
8 transfer conduits that transfer heat from hot
9 combustion products to a boiling water fluid for the
10 purpose of generating steam.
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13 12. The combination of claim 1 wherein the
14 steam generator includes an upright vessel, said outer
15 region having an upper level inlet flowing reformat
16 into the catalyst bed, the reformat containing carbon
17 monoxide, and said region having a lower level outlet,
18 a catalyst bed located between said upper and lower
19 levels, a heat transfer conduit or conduits extending
20 within said vessel and immersed within boiling water
21 contained in said vessel inwardly of said catalyst bed,
22 said conduit or conduits receiving hot products of
23 combustion from a combustion process, for transfer of
24 heat to the boiling water, for generating steam exiting
25 from said vessel.
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1 13. The combination of claim 1 wherein the
2 catalyst bed extends helically about said generator.

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5 14. The combination of claim 1 including a
6 helical coil in said outer region and extending about
7 said generator, to direct said reformat gases
8 helically and through said catalyst bed, to enhance
9 heat transfer via said bed.

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